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Environmental Noise Assessment

Ward Hill Substation No. 43
National Grid USA
Haverhill, Massachusetts

National Grid

Prepared by:

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Executive Summary

The Ward Hill Substation No. 43 (Substation) is located in Haverhill, Massachusetts. Final Substation design will include four 345/115 kV transformers, two 115/24 kV transformers, two 115/13.2 kV transformers, four 23/13.2 kV transformers, control house, and associated equipment.

An ambient noise survey was conducted August 4 and 5, 2004 to qualify and quantify the existing acoustic environment surrounding the Substation site. The results of the ambient survey were used to evaluate the potential for impacts related to Substation noise emissions.

The potential noise emissions from the Substation have been evaluated based on normal operation. Based on the evaluation, the increase in the ambient sound levels in the surrounding community due to the operation of the expanded Substation are not expected to result in significant impacts, although Substation noise emissions may be audible at certain times during the day.

1.0 Introduction

The Ward Hill Substation No. 43 (Substation) is located in Haverhill, Massachusetts. The potential noise emissions from the Substation have been evaluated. It is understood that the final design will include 12 transformers at the site. Currently, there are nine transformers located onsite, including one 345/115 kV transformer (T3), four 115/24 kV transformers (T1, T2A, T2B, and T2C), and four 23/13.2 kV transformers (L1 through L4). Transformers T1, T3, and L1 through L4 will remain onsite. Transformers T2A, T2B, and T2C will be replaced with a new transformer, T2. Transformers T4, T5, T6, T7, and T8 will be added as new equipment.

Based on the information provided, there are two residences located near the Substation that have been identified by National Grid as the primary receptors of concern. The nearest residence is approximately 260 feet from the Substation property boundary. Both residences are located east of the Substation on the opposite side of the adjacent railroad tracks.

An ambient noise survey was conducted on August 4 and 5, 2004 to qualify and quantify the existing acoustic environment surrounding the Substation site. The results of the ambient survey were used to evaluate the potential for impacts related to Substation noise emissions. Based on the survey results, the existing background sound levels ranged from 43 to 47 dBA throughout the measurement period (approximately 31 hours).

The potential facility noise emissions associated with the normal operation of the proposed expanded Substation have been evaluated. Future background sound levels were predicted based on the results of the ambient noise measurements and the Substation noise emissions predicted herein.

2.0 Acoustical Terminology

Environmental sound levels are quantified by a variety of parameters and metrics. In order to aid the reader, this section introduces general concepts and terminology related to acoustics and environmental noise.

2.1 Sound Energy Characteristics

Sound energy is physically characterized by amplitude and frequency. Sound amplitude is measured in decibels (dB) as the logarithmic ratio of a sound pressure to a reference sound pressure (20 microPa). The reference sound pressure corresponds to the typical threshold of human hearing. Generally, the average listener considers a 1 dB change in a constant broadband noise “imperceptible” and a 3 dB change "just barely perceptible". Similarly, a 5 dB change is generally considered "clearly noticeable" and a 10 dB change is generally considered a doubling (or halving) of the apparent loudness.

Frequency is measured in hertz (Hz), which is the number of cycles per second. The typical human ear can hear frequencies ranging from approximately 20 Hz to 20,000 Hz. Typically, the human ear is most sensitive to sounds in the middle frequencies (1,000 to 8,000 Hz) and is less sensitive to sounds in the low and high frequencies. As such, the A-weighting scale was developed to simulate the frequency response of the human ear to sounds at typical environmental levels. The A-weighting scale emphasizes sounds in the middle frequencies and de-emphasizes sounds in the low and high frequencies. Any sound level to which the A-weighting scale has been applied is expressed in A-weighted decibels, dBA. For reference, the A-weighted sound pressure levels associated with some common noise sources are shown in Table 2-1.

2.2 Environmental Noise Metrics

Noise in the environment is constantly fluctuating, such as when a car drives by, a dog barks, or a plane passes overhead. Several noise metrics have been developed to quantify fluctuating noise levels. These metrics include the equivalent-continuous sound level and the exceedance sound levels.

The equivalent-continuous sound level, L_{eq}, is the level of a hypothetical steady sound that has the equivalent sound energy as the actual fluctuating sound over a given time duration. For example, L_{eq}(1h) is the equivalent-continuous sound level measured over a one-hour period and provides an indication of the average sound energy over the one-hour period.

The exceedance sound level, L_x, is the sound level exceeded "x" percent of the sampling period and is referred to as a statistical sound level. The most common L_x values are L_{90}, L_{50}, and L_{10}. L_{90} is the sound level exceeded 90 percent of the sampling period. L_{90} is often referred to as the residual sound level because it measures the background sound level without the influence of loud, transient noise sources. L_{50} is the sound level exceeded 50 percent of the sampling period or the median sound level. L_{10} is the sound level exceeded 10 percent of the sampling period. L_{10} is often referred to as the intrusive sound level because it measures the occasional louder noises.

The variation between the L_{90}, L_{50}, and L_{10} sound levels can provide an indication of the variability and distribution of the noise environment. If the noise environment were perfectly steady, all values would be identical. A large variation between the values would indicate a large range of sound levels within the environment. For instance, measurements near a roadway with frequent passing vehicles would cause a large variation in the statistical sound levels.

2.3 Human Response to Noise

Noise is often considered unwanted sound. However, human response to noise is complex and is influenced by a variety of acoustic and non-acoustic factors. Acoustic factors generally include the sound's amplitude, duration, spectral content, and fluctuations. Non-acoustic factors typically include the listener's ability to become used to the noise, the listener's attitude towards the noise and the noise source, the listener's view of the necessity of the noise, and the predictability of the noise. As such, response to noise is highly individualized.

Table 2-1 Typical Sound Pressure Levels Associated with Common Noise Sources			
Sound Pressure Level (dBA)	**Subjective Evaluation**	**Environment**	
		Outdoor	**Indoor**
140	Deafening	Jet aircraft at 75 ft	
130	Threshold of pain	Jet aircraft takeoff at 300 ft	
120	Threshold of feeling	Elevated train	Rock band concert
110	Extremely Loud	Jet flyover at 1000 ft	Inside propeller plane
100	Very Loud	Motorcycle at 25 ft, auto horn at 10 ft, crowd noise at football game	
90	Very Loud	Propeller plane flyover at 1000 ft, noisy urban street	Full symphony or band, food blender, noisy factory
80	Moderately Loud	Diesel truck (40 mph) at 50 ft	Inside auto at high speed, garbage disposal, dishwasher
70	Loud	B-757 cabin during flight	Close conversation, vacuum cleaner, electric typewriter
60	Moderate	Air-conditioner condenser at 15 ft, near highway traffic	General office
50	Quiet		Private office
40	Quiet	Farm field with light breeze, birdcalls	Soft stereo music in residence
30	Very quiet	Quiet residential neighborhood	Bedroom, average residence (without t.v. and stereo)
20	Very Quiet	Rustling leaves	Quiet theater, whisper
10	Just audible		Human breathing
0	Threshold of hearing		

Source: Adapted from Architectural Acoustics, M. David Egan, 1988 and Architectural Graphic Standards, Ramsey and Sleeper, 1994.

3.0 Existing Acoustic Environment

In order to characterize the existing acoustic environment surrounding the Substation site, an ambient sound level survey was conducted. This section describes the results of the survey and the nature of the existing acoustic environment surrounding the project site.

3.1 General Community Noise

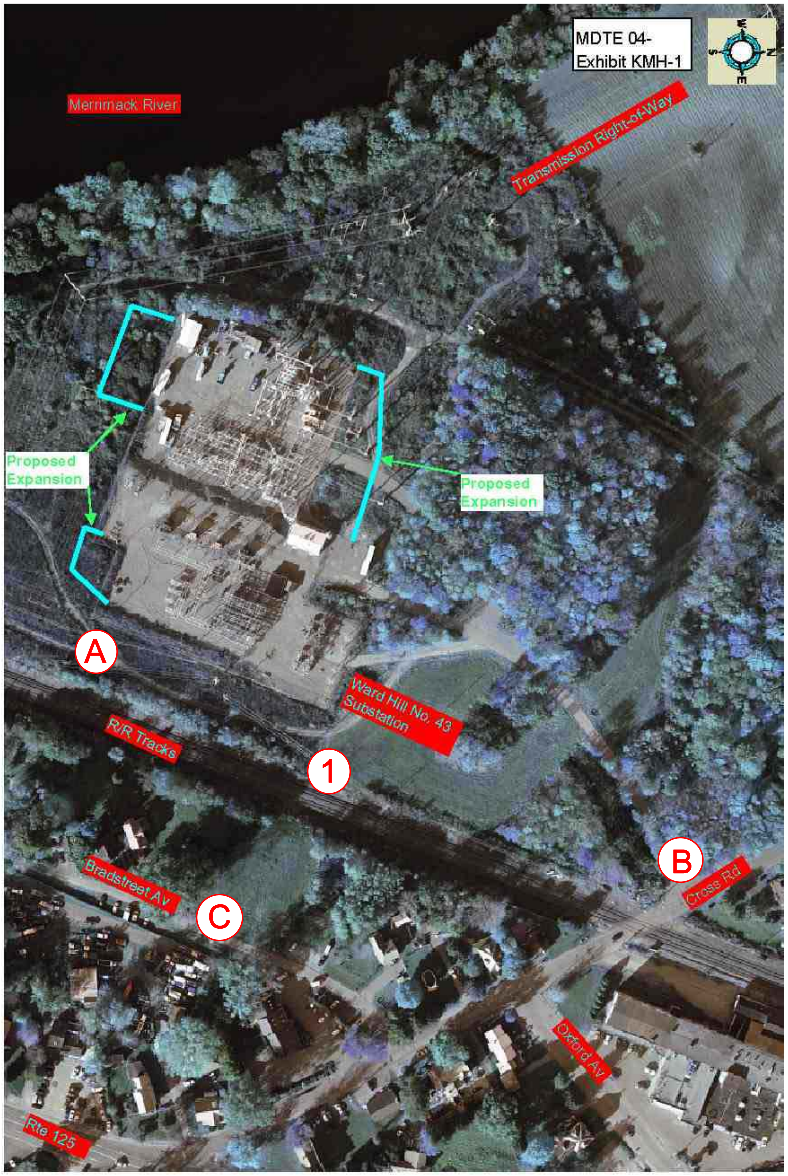
The existing acoustic environment around the Substation site is typical of smaller communities. The primary sources of noise include local traffic, commuter train traffic, Ward Hill Substation, occasional aircraft flyovers, and natural sounds (i.e., insects, birds, and light breezes).

3.2 Survey Procedure and Conditions

The ambient sound level survey was conducted on August 4 and 5, 2004 to characterize the existing acoustic environment at nearby noise sensitive receptors. The ambient sound level survey procedure was based on general industry test standards including ANSI S12.9, ANSI S12.18, and ANSI S1.13. In order to effectively quantify and qualify the existing daily sound levels, the ambient survey included both continuous monitoring and short-term measurements.

The sound level survey was conducted at locations surrounding the project site. The locations were selected to capture acoustical environments representative of the nearby noise-sensitive receptors (i.e., residences). Each measurement location is identified in Figure 3-1 and described in Table 3-1.

Ward Hill Substation, Haverhill



Ⓐ Ⓑ Ⓒ Short-term Measurement Location

① Continuous & Short-term Measurement Location

Figure 3-1

Noise Measurement Locations

Table 3-1
Noise Measurement Locations

Location	Description	Continuous Monitoring	Short-term Measurements
NML-1	East of the Substation, generally in line with the nearest receptors.	Yes	Yes
A	Near the east-southeast Substation property boundary, in line with the nearest residences in that direction from the Substation.	No	Yes
B	Near the access road entry gate from Cross Road.	No	Yes
C	Near the nearest residences east of the Substation, on Bradstreet Avenue.	No	Yes

Weather conditions during the August 4 - 5, 2004 survey were generally favorable for sound level measurements. Temperatures ranged from approximately 63 to 87 °F and the relative humidity ranged from approximately 53 to 76 percent. Winds were calm at 0 to 2 mph. During early morning hours of August 5, some light rain was experienced. Otherwise, skies ranged from cloudy to mostly sunny.

All sound level measurements were conducted using either a Type 1 or 2 sound level meter that met the requirements of ANSI S1.4. The sound level meters had integrating capabilities to determine the average and statistical sound levels over a specified duration. The microphones were equipped with windscreens provided by the manufacturer. The equipment is listed in Table 3-2 and calibration certification is provided in Appendix A of this report.

Table 3-2 Ambient Survey Test Equipment		
Model	**Serial Number**	**Last Calibration Date**
Rion Model NA-27	01191119	11/4/2003
Rion Type UC-53 Microphone	99858	11/4/2003
Norsonic Type 1251 Acoustic Calibrator	25762	11/4/2003
Rion Model NL-22	01110135	11/24/2003
Rion Model NL-22	01110133	11/24/2003
Rion Model NL-22	01110122	11/24/2003
Rion Model NC-73 Acoustic Calibrator	10527795	11/25/2003

3.3 Continuous Monitoring

Continuous noise monitoring was conducted at location NML-1 for approximately 31 hours to capture typical ambient daytime and nighttime sound levels. The measurements included the L_{eq}, L_1, L_{10}, L_{50}, and L_{90} sound levels. The results of the continuous monitoring provided an indication of the daily trends in the ambient sound level.

The continuous noise monitoring results are detailed in Table 3-3 and Figure 3-2, which depict the L_{10}, L_{50}, and L_{90} hourly sound levels during the monitoring period. As previously discussed, the L_{90} sound level is generally considered representative of the residual or background sound level (i.e., without discrete noise events such as occasional traffic, aircraft, dogs, etc.), the L_{50} sound level is considered the median sound level, and the L_{10} sound level is generally considered the intrusive sound level (i.e., with the occasional discrete events such as traffic, aircraft, etc.).

The continuous monitoring results indicated that the loudest times of the day occurred during early morning hours between 3:00 AM and 7:00 AM. The ambient sound level during the remaining hours of the day is relatively constant. As such, the monitoring results do not indicate that there are any periods of the day when background sound levels (L_{90}) are significantly quieter than the average for the day. However, the results indicate a noticeable increase in the L_{10} and L_{50} sound levels during early morning hours, possibly due to increased traffic and/or train passes. It is important to note that during the monitoring period, the existing Substation was continuously operating and therefore always part of the ambient acoustic environment. At the continuous monitoring location, the average hourly background sound level (L_{90}) was 44 dBA and the quietest hourly background sound level (L_{90}) was 43 dBA. In general, the background sound level is consistent with small communities that are remotely located from main arterials. However, it should be noted that a number of short-duration train passes were observed during the survey.

Table 3-3
Continuous Monitoring Results

Location	Hourly Exceedance Sound Levels, dBA			
		L_{90} (Background)	**L_{50}** (Median)	**L_{10}** (Intrusive)
NML-1	Maximum	47	53	60
	Average (Median)	**44**	46	50
	Minimum (Quietest)	43	44	46

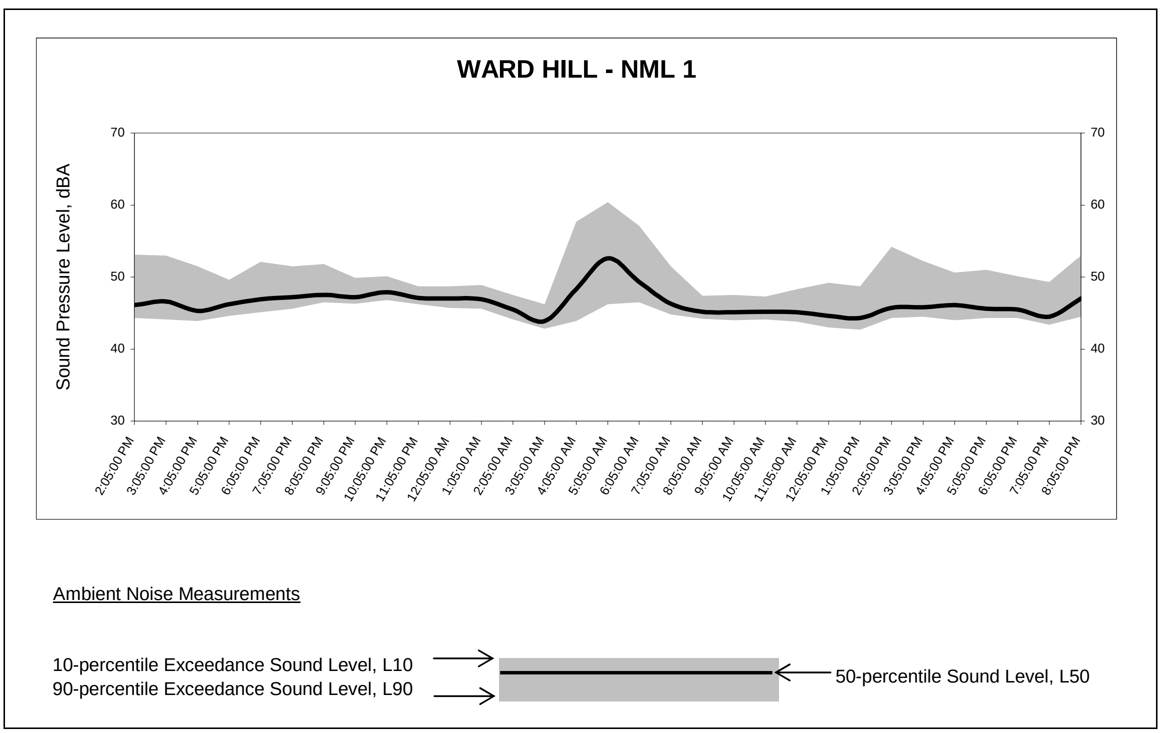


Figure 3-2
Results of Continuous Noise Monitoring

3.4 Short-Term Measurements

In addition to the continuous monitoring, manned, short-term noise measurements were conducted at NML-1 as well as three additional locations in the neighborhood. The short-term measurements supplemented the monitoring results by providing additional information. Specifically, these measurements helped to qualify the surrounding noise sources and provided an indication of the spectral content of the existing acoustical environment. The measurement periods ranged from 2 to 20 minutes in order to capture sound levels representative of each location during different time periods during the day. It should be noted that short-term measurements at Locations A, B, and C were limited to nighttime hours in order to qualify the acoustic environment during more sensitive periods.

The short-term measurement results for each location are listed in Table 3-4 and are detailed in Figures 3-3 and 3-4. The results listed in Table 3-4 are consistent with the continuous monitoring results previously discussed. The figures show the background (L_{90}) octave band sound pressure levels for each location at varying times throughout the day.

Table 3-4
Short-Term Measurement Results

Location	Measured Sound Levels, dBA					
	Time	**Duration** (min)	**L_{90}**	**L_{50}**	**L_{10}**	**Audible Sources**
NML-1	2:11 PM	20	46	47	55	Insects, Ward Hill Substation, aircraft, distant traffic, commuter train pass (w/ whistle).
	12:44 PM	20	47	49	52	Insects, Ward Hill Substation, commuter train, local traffic, distant traffic, distant aircraft.
	12:21 AM	20	49	50	51	Insects, Ward Hill Substation, distant traffic, local traffic.
A	12:58 AM	15	48	48	49	Insects, Ward Hill Substation, distant traffic, local traffic.
B	1:17 AM	12	48	48	49	Insects, distant traffic, barking dog.
C	1:34 AM	2	49	50	52	Insects, distant traffic.

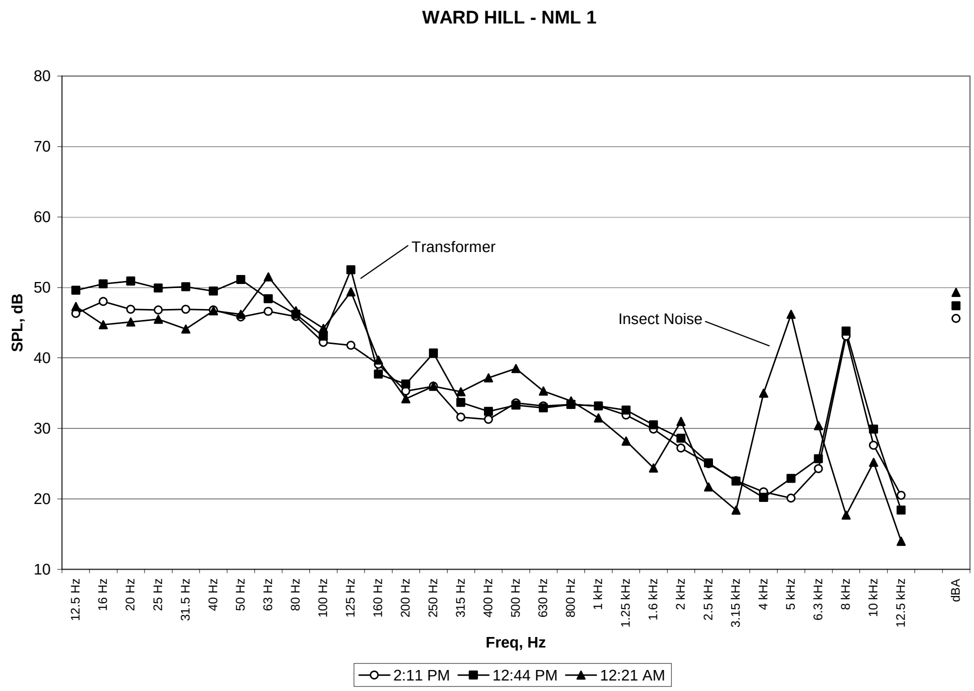


Figure 3-3
NML-1: Measured Background One-Third Octave Band Sound Pressure Levels (L_{90})

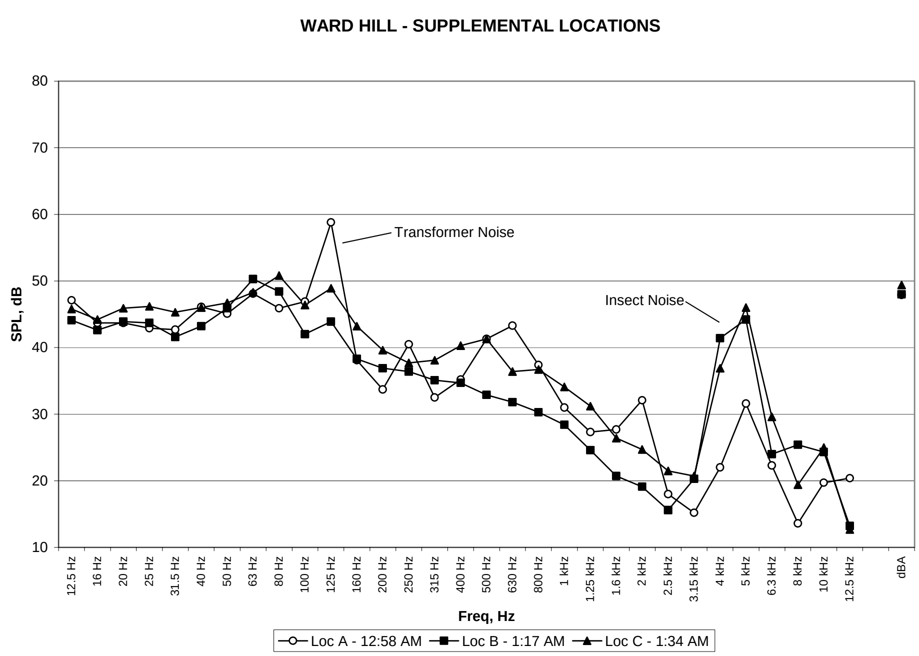


Figure 3-4
Supplemental: Measured Background One-Third Octave Band Sound Pressure Levels (L_{90})

4.0 Future Substation Noise Emissions

The environmental noise emissions associated with the proposed Substation have been estimated in order to evaluate the potential future noise impacts on the neighboring noise sensitive receptors.

4.1 Noise Modeling Methodology

The environmental noise emissions were modeled using noise prediction software (CadnaA version 3.3.107). The model simulated the outdoor propagation of sound from each noise source and accounted for sound wave divergence, atmospheric and ground sound absorption, sound directivity, and sound attenuation due to interceding barriers and topography. A database was developed which specified the location, octave band sound levels, and sound directivity of each noise source. A receptor grid was specified which covered the entire area of interest and was based on a receptor height of five feet above grade. The model calculated the overall A-weighted sound pressure levels within the receptor grid based on the octave band sound level contribution of each noise source. Finally, a noise contour plot was produced based on the overall sound pressure levels within the receptor grid, including specific receptor locations.

Each transformer was modeled as an individual point source. The point sources representing transformers T3-T6 were included at 16 feet above grade. The point sources representing T1,T2, T7, and T8 were included at 12 feet above grade. The point sources representing L1 – L4 were included at eight feet above grade. These heights were chosen conservatively and are approximately equal to the maximum height of the transformer tanks, respectively.

4.2 Equipment Noise Sources

Based on the proposed site plan drawing (National Grid Drawing H-77318a-P, dated 06/23/04), the project will include four 345/115 kV transformers, two 115/23 kV transformers, two 115/13.2 kV transformers, and four 23/13.2 kV transformers. Secondary noise sources are expected to include building wall fans and HVAC units associated with the control buildings. All of these potenial noise sources were considered in the evaluation.

Equipment sound levels were based on a combination of project specific data, data collected during the Substation site survey, available in-house data, and data provided by the Edison Electric Institute (EEI) in the *Electric Power Plant Environmental Noise Guide* (1984).

4.3 Substation Noise Emissions

The Substation noise emissions were modeled based on OA and FAFA operation of the final proposed development (i.e., transformers T1 through T8 and L1 through L4). Units T1 and T2 are understood to be 115/24 kV transformers. Units T3 through T6 are understood to be 345/115 kV transformers. Units T7 and T8 are understood to be 115/13.2 kV transformers. Units L1 through L4 are understood to be 23/13.2 kV transformers.

4.3.1 Predicted Noise Emissions

The resulting facility noise emissions associated with Substation operation are presented in Figure 4-1 as noise contours. Also shown in Figure 4-1 are the nearest noise sensitive receptors previously identified as the primary receptors of concern (shown as R1 and R2). As shown, the sound pressure levels at the nearest noise sensitive receptors due to Substation operation range from approximately 41 dBA to 46 dBA. It is important to note that these levels represent only the noise associated with the proposed Substation. They do not include the influence of any background noise not associated with the proposed Substation. Specific Substation sound level estimates at the two receptor locations are provided in Table 4-1.

Table 4-1
Estimated Substation Noise Emissions

Location	OA Operation, dBA	FAFA Operation, dBA
R1	44	46
R2	41	43

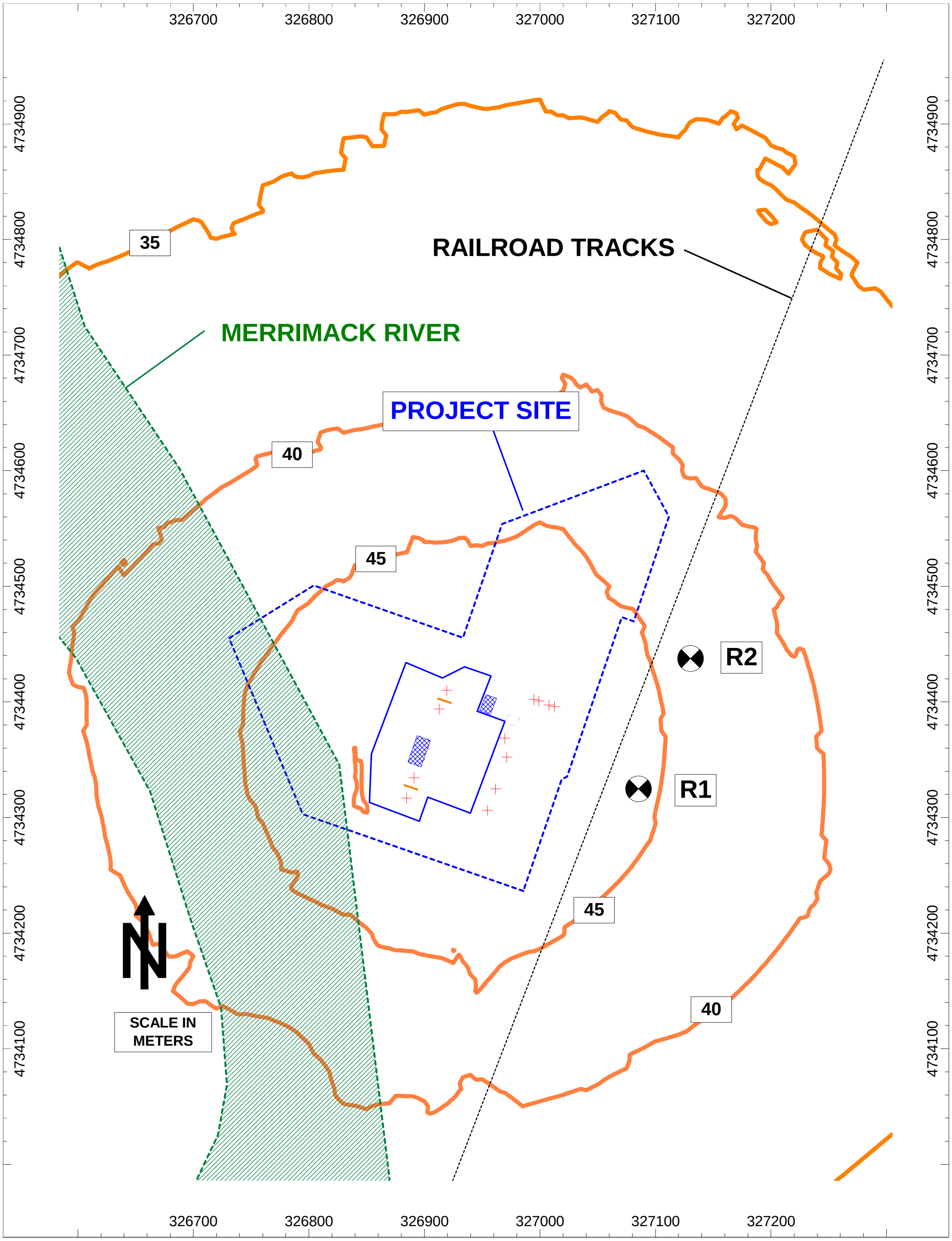


Figure 4-1
Substation Noise Emissions

4.3.2 Future Background Sound Levels

In order to evaluate the potential noise impacts on the neighboring noise sensitive receptors during operation, the predicted future Substation sound levels are compared to the measured existing sound levels in Table 4-2. As shown, the *increase* in the existing background sound level due to operation of the Substation is expected to range from 1 to 5 dB at the nearest receptors. As stated in Section 2.1 of this report, a 1 dB change in constant broadband noise is typically considered “imperceptible” by the average listener. Similarly, a change of 5 dB is typically considered “clearly noticeable” by the average listener.

The results of the ambient noise measurements indicate that the existing sound levels range from 43 dBA to 47 dBA during both daytime and nighttime hours, indicating little variation in the background sound level throughout the day. As such, it is expected that noise from the proposed Substation would be consistent with the existing acoustic environment during most periods of the day. However, a slight increase in the ambient sound level is expected to occur during the quietest periods of the day.

For comparison, Substation noise emissions were evaluated based on OA operation and FAFA operation. The estimated Substation noise emissions during OA operation are presented in Table 4-2. Similarly, the estimated Substation noise emissions during FAFA operation as presented in Table 4-3.

Table 4-2
Predicted Future Background Sound Levels During OA Operation

Noise Receptor Locations		**Measured Background Sound Level, dBA[3]**		**Predicted Facility Sound Level, dBA[4]**	**Future Background Sound Level w/ Facility, dBA**		**Future Background Sound Level Increase Due to Facility, dBA**	
NML	Description	*min[1]*	*max[2]*		*min[1]*	*max[2]*	*min[1]*	*max[2]*
R1	Residence located approximately 250 feet east of the Substation boundary.	43	47	44	47	49	4	2
R2	Residence located approximately 340 feet east-northeast of the substation boundary.	43	47	41	45	48	2	1

NOTES
1. During the quietest measured background noise.
2. During loudest measured background noise.
3. Assumes the measured ambient sound levels are representative of R1 and R2 ambient sound levels.
4. Based on OA operation.

Table 4-3
Predicted Future Background Sound Levels During FAFA Operation

Noise Receptor Locations		Measured Background Sound Level, dBA[3]		Predicted Future Substation Sound Level, dBA[4]	Future Background Sound Level w/ Substation, dBA		Future Background Sound Level Increase Due to Substation, dBA	
NML	Description	*min*[1]	*max*[2]		*min*[1]	*max*[2]	*min*[1]	*max*[2]
R1	Residence located approximately 250 feet east of the Substation boundary.	43	47	46	48	50	5	3
R2	Residence located approximately 340 feet east-northeast of the substation boundary.	43	47	43	46	48	3	1

NOTES
1. During the quietest measured background noise.
2. During loudest measured background noise.
3. Assumes the measured ambient sound levels are representative of R1 and R2 ambient sound levels.
4. Based on full load operation and max cooling.

Figure 4-2 provides a comparison of the Substation noise emissions (indicated by the dotted line) with the measured background noise described in Section 3.0 of this report. As shown in Figure 4-2, the Substation noise emissions are consistent with the existing ambient sound levels and therefore should not cause a significant impact to the surrounding acoustic environment.

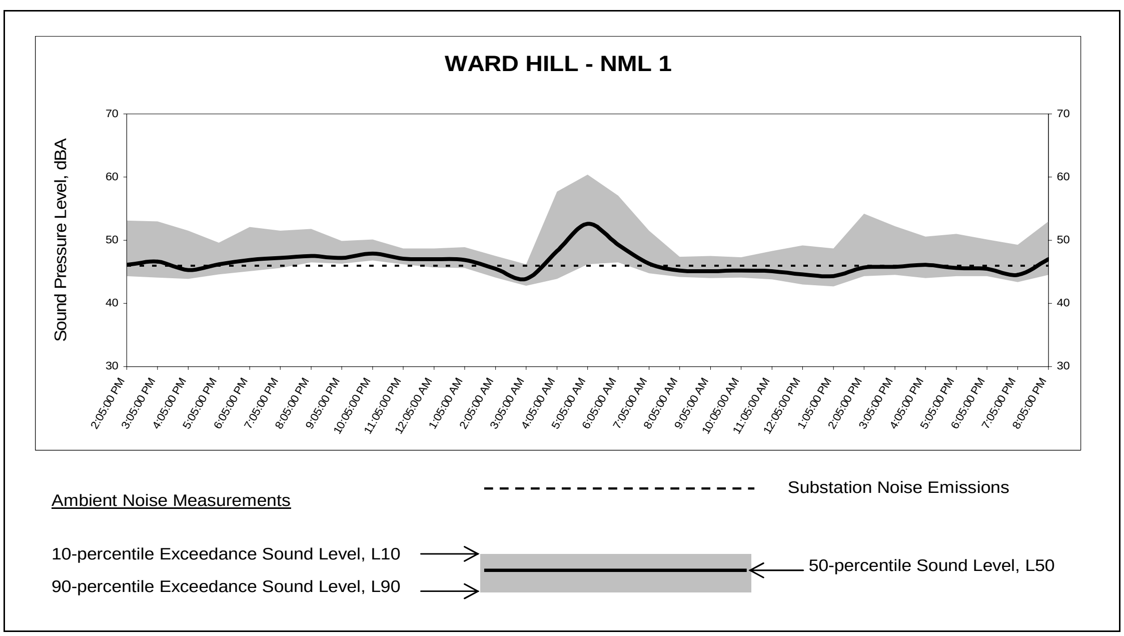


Figure 4-2
Comparison of Substation Noise Emissions and Existing Conditions

4.3.3 Elevated Receptor Positions

Substation noise emissions were also evaluated based on potential impacts to receptors located in an elevated position. Specifically, the evaluation considered receptors located 20 feet above grade (e.g., the second story of a residence). Again, Substation noise emissions during both OA operation and FAFA operation were evaluated and the results are provided in Table 4-4 and Table 4-5, respectively.

Table 4-4
Predicted Future Background Sound Levels During OA Operation
Receptors Located 20 Feet Above Grade

Noise Receptor Locations		**Measured Background Sound Level, dBA[3]**		**Predicted Facility Sound Level, dBA[4]**	**Future Background Sound Level w/ Facility, dBA**		**Future Background Sound Level Increase Due to Facility, dBA**	
NML	Description	*min[1]*	*max[2]*		*min[1]*	*max[2]*	*min[1]*	*max[2]*
R1	Residence located approximately 250 feet east of the Substation boundary.	43	47	47	48	50	5	3
R2	Residence located approximately 340 feet east-northeast of the substation boundary.	43	47	44	47	49	4	2

NOTES
1. During the quietest measured background noise.
2. During loudest measured background noise.
3. Assumes the measured ambient sound levels are representative of R1 and R2 ambient sound levels.
4. Based on OA operation.

Table 4-5
Predicted Future Background Sound Levels During FAFA Operation
Receptors Located 20 Feet Above Grade

Noise Receptor Locations		**Measured Background Sound Level, dBA[3]**		**Predicted Facility Sound Level, dBA[4]**	**Future Background Sound Level w/ Facility, dBA**		**Future Background Sound Level Increase Due to Facility, dBA**	
NML	Description	*min[1]*	*max[2]*		*min[1]*	*max[2]*	*min[1]*	*max[2]*
R1	Residence located approximately 250 feet east of the Substation boundary.	43	47	48	49	51	6	4
R2	Residence located approximately 340 feet east-northeast of the substation boundary.	43	47	46	48	50	5	3

NOTES
1. During the quietest measured background noise.
2. During loudest measured background noise.
3. Assumes the measured ambient sound levels are representative of R1 and R2 ambient sound levels.
4. Based on FAFA operation.

It is important to note that the measured background sound levels are representative of a receptor at 5 feet above grade and that background sound levels may be slightly different at 20 feet above grade due to reduced ground attenuation and improved line of sight between the receptor and neighborhood noise sources. As such, the increase in future background sound levels may be slightly lower than the levels presented in Table 4-4 and Table 4-5.

4.4 Prominent Discrete Tones

In addition to the overall sound level, discrete tones (audible hums) are often a concern with transformer installations. As defined in ANSI S1.13, a discrete tone is classified as being prominent if the sound pressure level of the critical band containing the tone (typically 63 Hz, 125 Hz, and 250 Hz in transformers) exceeds the average sound pressure level of the adjacent bands by 7 dB. This is typically evaluated by narrow band or one-third-octave band analysis.

Based on the results of the ambient noise survey, prominent discrete tones were found to currently exist in some areas surrounding the Substation. Specifically, a tone in the 125 Hz band was identified. Based on the survey results, the tone is associated with the Ward Hill Substation equipment.

5.0 Conclusions

The ultimate Ward Hill Substation No. 43 project includes the installation of six transformers and relocation of two existing transformers. In addition, the existing T2A, T2B, and T2C transformers will be replaced with one new 115/24 kV transformer. Transformers L1 through L4 will remain in their current location. Final project development will result in a total of twelve transformers being located at Ward Hill Substation No. 43. The existing Substation includes a total of nine transformers.

The results of the ambient noise survey indicate that the existing acoustic environment experiences consistent background sound levels throughout the day. Background sound levels (L_{90}) ranged from 43 to 47 dBA and were consistent during both daytime and nighttime hours. It should be noted that the measured background noise (i.e., existing conditions) included the contribution of the existing Substation equipment and that some of the existing equipment will be removed from the Substation as part of project development.

The expected future Substation noise emissions are expected to range from 41 to 44 dBA during OA operating conditions and from 43 to 46 dBA during FAFA operating conditions at the nearest residential receptors. Future Substation noise emissions include the influence of both the existing equipment that will remain onsite and the proposed new equipment.

Furthermore, the results of the modeling do not indicate significant impacts related to prominent discrete tones. It is anticipated that sound levels in the 125 Hz and 250 Hz bands will be consistent with existing conditions and that a significant increase is not expected. The limited increase is partially due to the fact that the existing equipment already contributes to the sound levels in these two bands and that the contribution of the new equipment will be offset by the removal of some of the existing equipment.

Finally, the increase in the future background sound level at the nearest residences is expected to be approximately 1-3 dB during periods of typical noisy background and occasionally as much as 5 dB during periods of quiet background and simultaneous operation of all transformers at the FAFA level. The increase in the future background sound levels is based on the ambient data collected during the August 4 – 5, 2004 survey. Typically, increases in sound levels of 1-3 dB range from “imperceptible” to “just barely perceptible” and an increase of 5 dB is considered “clearly noticeable” by average listeners.

Appendix A

Scantek, Inc.

CALIBRATION
LABORATORY

Calibration Certificate No.11672

Instrument:	**Sound Level Meter**
Model:	**NA27**
Manufacturer:	**Rion**
Serial number:	**01191119**
Tested with:	**Microphone UC-53 s/n 99858** **Preamplifier NH-20 s/n 94641**
Customer:	**Black & Veatch**
Tel/Fax:	**913-458-2675**

Date Calibrated: **November 4, 2003**

Status	**Received**	**Sent**
In tolerance	X	X
Out of tolerance		
See comments		

Address: **11401 Lamar Ave.**
Overland Park, KS 66211

Tested in accordance with the following procedures and standards:
Calibration of Sound Level Meters, Scantek Inc., 01/28/2002 that describes the pertinent tests from the following standards: IEC 60651/1979, and ANSI S1.4/1983; IEC 60804/1985 and ANSI S1.43/1997; IEC 1260/1995 or IEC225/1966 or ANSI S1.11/1986

Instrumentation* used for calibration: Nor-1504 Norsonic Test System:

Instrument - Manufacturer	Description	S/N	Cal date	Traceability evidence Cal. Lab / Accreditation
483B-Norsonic	SME Cal Unit	25747	May 16,2003	Scantek Inc.
DS-360-SRS	Function Generator	33584	Oct.6, 2003	Scantek Inc.
34401A-Agilent Technologies	Digital Voltmeter	MY41022043	Oct.2, 2003	Agilent Technologies / A2LA
DPI140-Druck	Pressure Indicator	790/00	Nov.21, 2002	Transcat / A2LA
HMP233-Vaisala Oyj	Humidity& Temp. Transmitter	V3820001	Oct.7, 2003	Transcat / A2LA
PC Program 1019 Norsonic	Calibration software	v.4.24	Validated Jan 2003	-
1253-Norsonic	Calibrator	25726	May 15, 2002	Scantek Inc.

***Traceable to SI- BIPM through NIST (USA).**

Environmental conditions:

Temperature (°C)	Barometric pressure (kPa)	Relative Humidity (%)
24 ±2.0 °C	100.371 ±2.0 kPa	42.3 ±5 %RH

Calibrated by	Mariana Buzduga	**Checked by**	Richard J. Peppin
Signature	[signature]	Signature	[signature]
Date	11/5/2003	Date	03.11.05

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Scantek, Inc.

CALIBRATION
LABORATORY

Calibration Certificate No.11671

Instrument:	**Acoustical Calibrator**	*Date Calibrated:*	**2003-11-04**	
Model:	**1251**	*Status:*	**Received**	**Sent**
Manufacturer:	**Norsonic**	*In tolerance*	X	X
Serial number:	**25762**	*Out of tolerance:*		
Class (IEC 60942):	**1**	*See comments:*		
Barometer type:				
Barometer s/n:				
Customer:	**Black & Veatch**	*Address:*	**11401 Lamar Ave.**	
Tel/Fax:	**913-458-2675**		**Overland Park. KS 66211**	

Tested in accordance with the following procedures and standards:
Procedure for calibration of Acoustical Calibrators, Scantek Inc., 01/28/2002 that details the pertinent tests from the following standards: IEC 60942/1997, annex B; ANSI S1.40/1984

Instrumentation* used for calibration: Nor-1504 Norsonic Test System:

Instrument - Manufacturer	Description	S/N	Cal date	Traceability evidence Cal. Lab / Accreditation
483B-Norsonic	SME Cal Unit	25747	May 16,2003	Scantek Inc.
DS-360-SRS	Function Generator	33584	Oct.6, 2003	Scantek Inc.
34401A-Agilent Technologies	Digital Voltmeter	MY41022043	Oct.2, 2003	Agilent Technologies /
DPI140-Druck	Pressure Indicator	790/00	Nov.21, 2002	Transcat / A2LA
8903-HP	Audio Analyzer	2514A05691	Jan.8, 2003	Scantek, Inc
HMP233-Vaisala Oyj	Humidity& Temp.	V3820001	Oct.7, 2003	Scantek, Inc
PC Program 1018 Norsonic	Calibration	v.4.23	Validated Jan	-
1253-Norsonic	Calibrator	22909	Aug.26, 2003	Scantek Inc.
1203-Norsonic	Preamplifier	14051	Aug.1, 2003	Scantek Inc.
4134-Bruel&Kjaer	Microphone	173368	Aug.26, 2003	Scantek Inc.

*Traceable to SI - BIPM through NIST (USA), NFT (Norway), SP (Sweden)

Calibrated by	Mariana Buzduga	Checked by	Richard J. Peppin
Signature	*[signature]*	Signature	*[signature]*
Date	11/4/2003	Date	03-11-05

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Scantek, Inc.

CALIBRATION
LABORATORY

Calibration Certificate No.11670

Instrument:	**Microphone**	*Date Calibrated:*	**2003-11-04**	
Model:	**UC53**	*Status*	**Received**	**Sent**
Manufacturer:	**Rion**	*In tolerance*	**X**	**X**
Serial number:	**99858**	*Out of tolerance*		
		See comments		
Customer:	**Black & Veatch**	*Address:*	**11401 Lamar Ave.**	
Tel/Fax:	**913-458-2675**		**Overland Park, KS 66211**	

Tested in accordance with the following procedures and standards:
Procedure for Calibration of Measurement Microphones, Scantek Inc., 01/28/2002

Instrumentation* used for calibration: N-1504B Norsonic Test System:

Instrument - Manufacturer	Description	S/N	Cal date	Traceability evidence Cal. Lab / Accreditation
483B-Norsonic	SME Cal Unit	25747	May 16,2003	Scantek Inc.
DS-360-SRS	Function Generator	33584	Oct.6, 2003	SRS/Manufacturer
34401A-Agilent Technologies	Digital Voltmeter	MY41022043	Oct.2, 2003	Agilent Technologies /
DPI140-Druck	Pressure Indicator	790/00	Nov.21, 2002	Transcat / A2LA
HMP233-Vaisala Oyj	Humidity& Temp. Transmitter	V3820001	Oct.7, 2003	Transcat / A2LA
PC Program 1017 Norsonic	Calibration software	v.4.24	Validated Jan 2003	-
1253-Norsonic	Calibrator	22909	Aug.26, 2003	Scantek Inc.
1203-Norsonic	Preamplifier	14051	Aug.1, 2003	Scantek Inc.
4134-Bruel&Kjaer	Microphone	173368	Aug.26, 2003	Scantek Inc.
840-2-Norsonic	Real Time Analyzer	18692	July 12, 2003	Scantek, Inc

*Traceable to SI - BIPM through NIST (USA), NFT (Norway), SP (Sweden)

Calibrated by	Mariana Buzduga	Checked by	Richard J. Peppin
Signature		Signature	
Date	11/4/2003	Date	03.11.05

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